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# An analysis and comparison of scientometric data between journals of physics, chemistry and engineering

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By employing the Pearson correlation, Fisher- and t-tests, the present study analyzes and compares scientometric data including number of source items, number of citations, impact factor, immediacy index, citing half-life and cited half-life, for essential journals in physics, chemistry and engineering, from SCI JCR on the Web 2002. The results of the study reveal that for all the scientometric indicators, except the cited half-life, there is no significant mean difference between physics and chemistry subjects indicating similar citation behavior among the scientists. There is no significant mean difference in the citing half-life among the three subjects. Significant mean difference is generally observed for most of the scientometric indicators between engineering and physics (or chemistry) demonstrating the difference in citation behavior among engineering researchers and scientists in physics or chemistry.

Significant correlations among number of source items, number of citations, impact factor, and immediacy index and between cited half-life and citing half-life generally prevail for each of the three subjects. On the contrary, in general, there is no significant correlation between the cited half-life and other scientometric indicators. The three subjects present the same strength of the correlations between number of source items and number of citations, between number of citations and impact factor, and between cited half-life and citing half-life.

## Introduction

The scholarly journal has been usually employed as a fundamental unit for analysis by many bibliometricians. This is because 1) the scholarly journal is the major platform

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for recording and communicating research and other scholarly activities in the sciences; and 2) ISI Thompson publishes Journal Citation Reports, Science Citation Index, Social Sciences Citation Index, and other citation index tools [WHITE & MCCAIN, 1989]. Many factors, such as journal citation analysis, journal productivity, and evaluation by subject experts, may be employed to judge the value of journals. Indeed, the journal citation analysis has become a dominant evaluation tool with applications in various disciplines. A journal citation analysis is thought to be important in researcher's academic life and in the universities' research assessment exercise in many institutions. Moreover, a journal citation analysis can also show how knowledge is changing, or becoming obsolescent, and help optimize an information retrieval system. Obsolescence is another major focus of the evaluation of journal value. The essential question to be answered by a study of obsolescence is how long will a publication continue to be used after it has been published? The rate of obsolescence can be determined by the cited half-life or citing half-life of a journal. It is not known, however, whether the most productive journals in a particular subject field are also those that have the most citations or the highest impact factor. It is also not known whether the most productive journals are also those that have the longest cited half-life and citing half-life.

According to VINKLER's definition [2001, P. 541], "scientometric indicator is a scientometric measure which can be attributed to scientometric organizations" and which can be classified into basic indicators, e.g., number of citations and number of papers, etc. and complex ones, which is on the basis of relations between the referencing and referenced sets. The primary objective of the present study is to investigate the relationship and difference between journal scientometric indicators, i.e., number of source items, number of citations, impact factor, immediacy index, cited half-life and citing half-life in the subjects of physics, chemistry and engineering. Physics and chemistry are two of the most important subjects for science, while engineering can be considered as the application of basic sciences. Indeed, engineering is defined as "the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize economically the materials and forces of nature for the benefit of mankind." [REYES-GUERRA, 2006]. It is, therefore, also very interesting to explore the similarities and differences in citation behavior among these three subjects. The results of this study should be of significant interest for the journal collection management in a science and technology library as well as for making research policy for a research institute.

In the present study, the journal scientometric data were drawn from SCI Journal Citation Reports (JCR) on the Web 2002. This study also investigates the relationship and difference between each pair of six kinds of scientometric data, i.e. number of source items, number of citations, impact factor, immediacy index, citing half-life and cited half-life for journals of these three subjects. Statistical tests such as the Pearson correlation, Fishers test and t-test are employed to examine the correlation among scientometric indicators, compare the strength of correlation, and the mean difference of scientometric data among essential journals of physics, chemistry and engineering.

## Literature review

As the studies in the literature demonstrated, one obvious criterion for the evaluation of journals is that of productivity, which can be expressed as number of papers published by a journal in a specific subject field during a particular period of time. Other common measures of journal value are total citation count, impact factor and the rate of obsolescence. There are only a few studies investigating the relationship between journal productivity and journal value though separate studies in both are quite abundant. For example, using the literature of dye laser, MAGYAR [1974], found that 60% of the articles most cited appear in the most productive journals of the top Bradford distribution nucleus zone. BOYCE & POLLENS [1982], using citation as a measure of quality, they found a strong correlation between productivity and total number of citations. Nevertheless, no significant correlation exists between productivity and either "impact factor" (number of citations earned per paper published) or "quality weight". The quality weight is a type of impact factor but restricted to the papers contributed by these journals to the sub-field. It is calculated by dividing the number of citations to bibliography items in a journal by the number of bibliography items the journal published during a specified period of time. SEGLEN [1992] indicated that the distribution of citations among documents in a journal appears to be skewed. He reported that 15% of a journal's articles include half of the citations, and the most cited 50% of the articles account for nearly 90% of the citations. Moreover, he also found that the citation practices are different between the based and applied sciences. For corresponding to the Garfield's impact factor, VINKLER [2004] developed a new indicator, Specific Impact Contribution (SIC), to characterize the impact of a subset of articles or journals. He demonstrated that the normalized Garfield's Impact Factors of journals and the normalized SIC indicators are identical measures within any set of journals selected in his study.

ROUSSEAU & VAN HOOYDONK [1996] showed that there exists a direct linear relation between journal production and impact factor. They observed that the more articles a normal journal publishes, the larger its impact factor. When considering disciplines, among 12 science, technology and health science areas, mathematics and chemistry seem to be large-scale exceptions. CHO & AL. [1998] studied the value of infectious disease journals by using the JCR. The assessed journals are ranked according to their 1995 impact factor, and their JCR ranks according to number of citations. They found that overall; the journals with the highest rankings by impact factor had high number of citations. JEMEC [2001] conducted a detailed study of dermatological journals listed in the JCR 1991–2000 and found a significant linear correlation between the number of journals in a given field and the top impact factor of that field. Studying the trend for dermatological journals 1991 to 2000 a similar pattern was found. Significant correlations were also found between total number of journals and mean impact factor, between the total number of journals and the top impact factor and between the mean and the top impact factor. By employing scientometric indicators, VINKLER [2000] did an evaluation of the publication activity of the Institute of Chemistry, Chemical Research Center, Hungarian Academy of Science. He found that the eminence of the journals is characterized by Garfield (impact) Factor (GF). Applying reference standards of mean GF values, Vinkler found a mean value of GF of 2.897 for biochemistry and molecular biology journals; of 1.478 to 1.968 for journals in general, organic, physical, analytical and medical chemistry; and of 0.734 for applied chemistry, polymer sciences and chemical engineering journals.

There are also some studies examining the relationship between journal productivity and obsolescence. DE QUEIROZ & AL. [1981] addressed the question of how the journal productivity and obsolescence characteristics of a literature change over time. They observed that as thermoluminescent dosimetry literature grew it became increasingly scattered in terms of the number of contributing journals and that the rate, in terms of median citation age, of obsolescence decrease. WALLACE [1985] examined the relationship between journal productivity and journal obsolescence. After conducting a statistical test, he found that "highly productive journals did tend to have low journal median citation ages, and that high journal median citation ages were always associated with journals that were unproductive in terms of the number of references to those journals in the database." REN & ROUSSEAU [2002] analyzed some scientometric data provided by ISI's Journal Citation Reports (1998 edition) for 500 geo-science journals and concluded that number of source items, the total number of citations, the average journal impact factor and the average journal immediacy index all have smaller values than the average 5467 journals covered by the JCR. By employing Journal Citation Reports, KUHLEMEIER [1992] made a bibliometric analysis of the *Archives of Physical Medicine and Rehabilitation* and related journals. He found that the overall rankings of the Archives in 1988 compared to all journals indexed were 1887 of 4020 for impact factor, 2633 of 2683 for cited half-life and 1793 of 4020 for immediacy index. In general, Archives ranked higher in most of these indices than most rehabilitation journals but lower than other journals cited in the Archives, including general journals, other specialty journals, and a basic science journal.

MOED & AL. [1999] did a critical examination of the journal impact data in the JCR and found that the impact factor is inaccurate and the cited half-life is an inappropriate measure of decline of journal impact. They developed a normalized impact factor to correct differences of citation characteristics among subfields. They also modified the

JCR cited half-life by developing a system with 4 classes related to rapidity of maturing and 4 classes with respect to rapidity of impact decline.

The above review indicates that none of these previous studies can be considered truly conclusive, and conflicting results have been found. It has not been demonstrated that articles contributed to some subject area by the journals less productive in that field are necessarily of lower value, no matter whether value is measured by number of citations, impact factor or rate of obsolescence, than those appearing in the highly productive journals. Therefore, further studies that consider determining other parameters, such as cited half-life, citing half-life, immediacy index, etc. with relation to each other is needed.

## Methodology

In this study, the scientometric data were drawn from the SCI JCR Web 2002. The database, published by the Institute for Scientific Information, is an essential, comprehensive, and unique resource tool for journal evaluation, using scientometric data drawn from over 6000 scholarly and technical journals worldwide [ISI, 2004]. The JCR is the only source of scientometric data on journals, and shows the relationship between citing and cited journals in a clear, easy-to-use framework.

JCR provides a listing of journals ranked by scientometric data, such as impact factor, citing and cited half-life, etc. within a category. Specific descriptions of each of several citation parameters are given in the database. Six of these parameters – the number of citations, the number of source items, the impact factor, the immediacy index, the cited half-life, and the citing half-life – are examined and compared in this study. Pearson correlations from each pair of scientometric data were calculated to assess the significant relationship between each of the 15 pairs of these scientometric data. The Fisher's Z-transform was used to test the significant difference between the strength of Pearson correlation coefficient for each pair of scientometric data of the three subject areas. Moreover, the t-test was employed to examine the mean difference of scientometric data among essential journals of physics, chemistry and engineering.

In this study, essential journals for the three subjects were selected from the most current edition of *Guide to the Literature* reference tools. For example, *Guide to Information Sources in the Physical Sciences* [STERN, 2000], Chapter 3 lists 272 major physical journals. *Information Sources in Chemistry* [BOTTLE & ROWLAND, 1993], Chapter 2 illustrates 184 key journals for chemistry. *Guide to Information Sources in Engineering* [LORD, 2000], Chapter 4 covers 111 engineering journals. Journals common to both *Guide to the Literature* tools and JCR Science edition web 2002 are selected as the samples for the statistical test of journal scientometric data. Consequently, the essential journal samples of the present study for the subjects of physics, chemistry, and engineering are 236, 95 and 94, respectively.

## Definition of terms

The following definitions for some terms of scientometric data were drawn from SSCI JCR web 2004 [ISI, 2004].

*Number of source items and number of citations*

"Number of source items and number of citations are important indicators of how frequently current researchers are using individual journals. Number of source items shows the number of articles published in a journal in a particular year or years. Editorials, letters, news items, and meeting abstracts are not included in number of source items because they are not generally cited. Number of citations indicates the total number of times that each journal has been cited by all journals included in the ISI database within the current product year."

*Impact factor*

The journal impact factor is "a measure of the frequency with which the 'average article' in a journal has been cited in a particular year." The JCR impact factor is calculated by dividing the number of current citations to articles published in the two previous years by the total number of articles published in the two previous years.

*Immediacy index*

The journal immediacy index is "a measure of how quickly the "average article" in a journal is cited. It is calculated by dividing the number of citations to articles published in a given year by the number of articles published in that year." It will tell one how often articles published in a journal are cited within the same year.

*Cited half-life*

The cited half-life is "the number of publication years from the current year which account for 50% of current citations received. They basically reflect the timeliness with which articles in a journal are citing other articles, and are cited by other articles. This figure can help one evaluate the age of the majority of cited articles published in a journal."

*Citing half-life*

The citing half-life is "the number of publication years from the current year that account for 50% of the current citations published by a journal in its article references. This figure help one evaluate the age of the majority of articles referenced by a journal."

## Results and discussion

The data of number of source items, number of citations, impact factor, immediacy index, cited half-life and citing half-life were obtained from SCI JCR Web 2002 by the title-by-title search.

*Mean value of scientometric data*

Table 1 illustrates the mean value of various scientometric indicators for the essential journals of the three subjects under study, i.e., physics, chemistry, and engineering. Superficially, except for the cited half-life and citing half-life, the mean values of various scientometric indicators for the essential journals of engineering deviate significantly from those of the physics and chemistry. On average, a chemistry journal published slightly more papers than a physics journal, and a physics journal publishes about three times of papers as an engineering journal does. Because there are more articles to be cited, a chemistry journal gets more citations than a physics journal does, and a physics journal possesses citations more than four times of an engineering journal. The average impact factor for a physics or chemistry journal is around 2.10, while the average impact factor for an engineering journal is 0.921 only. The situation for the immediacy index is similar to that for impact factor for these three subject journal. To substantiate these observations, t-tests are conducted and the results are illustrated in Table 2.

Table 1. Mean value of scientometric indicators for essential journals in physics, chemistry and engineering

| Subject | Number of source items | Number of citations | Impact factor | Immediacy index | Cited half-life | Citing half-life |
|---|---|---|---|---|---|---|
| Physics | 407 | 10568 | 2.11 | 0.419 | 7.03 | 8.12 |
| Chemistry | 452 | 14867 | 2.08 | 0.326 | 7.96 | 8.28 |
| Engineering | 132 | 2546 | 0.92 | 0.142 | 7.83 | 8.00 |

*Mean difference tests*

It is interesting to explore the mean difference of scientometric data among the three subjects under study. Table 2 demonstrates that for the 18 pairs among the three subjects, there are 8 pairs without significant difference in scientometric data. In particular, for all the scientometric indicators of this study except the cited half-life, there is no significant difference between the essential journals of physics and chemistry. This may be understood that both physics and chemistry are fundamental sciences and the citation behavior among the scientists could be very similar. It is also interesting to note that for citing half-life, there is no significant mean difference for the three pairs among physics, chemistry and engineering. On the other hand, significant difference is generally observed between engineering and physics or between engineering and chemistry for most of the scientometric indicators. This demonstrates the difference in citation behavior among engineering researchers and scientists in physics or chemistry.

Table 2. Mean difference of scientometric data among journals in I: physics; II: chemistry; III: engineering

| Scientometric data | Subject pairs | t- value | p | Mean difference |
|---|---|---|---|---|
| Number of source items | I & II | –0.594 | 0.553 | –44.0 |
| | II&III | 5.44 | 0.000* | 319.0 |
| | I &III | 6.27 | 0.000* | 275.0 |
| Number of citations | I & II | –1.30 | 0.194 | –4299.0 |
| | II&III | 4.20 | 0.000* | 12320.0 |
| | I &III | 4.51 | 0.000* | 8021.0 |
| Impact factor | I & II | 0.10 | 0.917 | 0.032 |
| | II&III | 5.22 | 0.000* | 1.16 |
| | I &III | 6.39 | 0.000* | 1.19 |
| Immediacy index | I & II | 1.86 | 0.064 | 0.094 |
| | II&III | 5.21 | 0.000* | 0.184 |
| | I &III | 6.42 | 0.000* | 0.277 |
| Cited half-life | I & II | –3.74 | 0.000* | –0.934 |
| | II&III | 0.454 | 0.651 | 0.133 |
| | I &III | –3.04 | 0.003* | –0.800 |
| Citing half-life | I & II | –0.865 | 0.388 | –0.168 |
| | II&III | 1.16 | 0.246 | 0.282 |
| | I &III | 0.587 | 0.557 | 0.114 |

*$\alpha \leq 0.05$, there is significant difference

*Pearson correlation test*

As stated earlier in the previous section, the Pearson correlation was applied to determine the correlation coefficient between each pair of scientometric data. With six scientometric indicators under consideration, there are fifteen pairs for conducting the test. Table 3 shows the Pearson correlation coefficient of journals in the subjects of physics, chemistry and engineering for the fifteen pairs of scientometric indicators together with the p-value and the number of journals for each study pair in the parenthesis. For example, the correlation between number of source items and number of citations for the journals in the subject (I) physics is $r = 0.835$ with p-value of 0.000 and the number of journals for this subject pair is 233. On the other hand, the correlation between cited half-life and citing half-life for the journals in the subject (III) engineering is $r = 0.335$ with p-value of 0.002 and the number of journals for this subject pair is 86. There is significant variation in the magnitude of correlation. The correlation between impact factor and cited half-life for physics journals is as small as $r = 0.130$ with p-value of 0.047, which is smaller than 0.05 and the correlation is considered to be significant. Indeed, for the sample size of 235 for this case, the critical correlation value for $p = 0.05$ is 0.129 (MINIUM & CLARK [1982], Appendix H, p.A54).

*Physics*

Table 3 indicates that for essential journals in physics with 95% confidence interval ($p<0.05$) significant correlation exists between number of citations and number of source items, between number of citations and impact factor, between number of citations and immediacy index, between impact factor and immediacy index, between number of source items and cited half-life, between impact factor and cited half-life, between number of source items and citing half-life, between number of citations and citing half-life, between impact factor and citing half-life, between cited half-life and citing half-life, though the value of coefficient deviates quite significantly from pair to pair. The significant correlations between number of source items and number of citations, between number of citations and impact factor, between number of citations and immediacy index, and between impact factor and immediacy index can be understood as both impact factor and immediacy index are based on number of citations during one or two years. There is also an association between impact factor and cited half-life indicating that per paper for each journal that was cited more times tend to be cited longer. On the other hand, the positive correlation between citing half-life and cited half-life indicates that a physics journal with a short cited half-life tends to cite newly published articles and vise versa. Based on the "success-breeds-success" [PRICE, 1976] phenomenon one could expect that, the more articles a journal publishes, the higher its visibility, the higher its chance to be cited, and hence, the higher its impact factor and immediacy index. In contrast, journals with lower number of source items receive fewer citations and a lower impact factor. Moreover, the majority of articles referenced by these journals tend to be very recent. The impact factor and immediacy index also has significant correlation with number of citations since both two parameters are computed on the basis of total citation that each journal receives during one or two years.

There are several significant negative correlations between cited or citing half-life and other scientometric indicators. A significant negative correlation exists between citing half-life and number of citations and between citing half-life and impact factor. This suggests that a journal in the physics field with a large number of citations and high impact factor tends to cite newly published articles. The negative correlations between number of source items and cited half-life and between number of source items and citing half-life demonstrate that a physics journal published more papers tends to cite newer articles and would be cited with a shorter half-life.

*Chemistry*

As for the essential journals in the subject of chemistry, there are 12 out of 15 pairs correlate each other significantly. Seven out of the 12 significantly correlated pairs are positive, mainly for the correlations for the pairs among number of source items, number of citations, impact factor and immediacy index. Significantly, the citing half-life correlates negatively to number of source items, number of citations, impact factor, immediacy index, respectively. However, there is a significant positive correlation between citing half-life and cited half-life. In contrast to that for the citing half-life, the cited half-life has no association with other scientometric indicators except the immediacy index. This suggests that a chemistry journal with larger number of source items, number of citations, impact factor may not have longer cited half-life.

*Engineering*

Table 3 indicates that the test results of correlation among number of source items, number of citations, impact factor, and immediacy index for the essential engineering journals are all significant and positive, similar to that for essential journals in chemistry subject but with different strength. There is also an association between number of citations and cited half-life indicating that journals that cited more times tend to be cited longer. Significant correlation between cited half-life and citing half-life also present as for the essential journals in physics and chemistry. However, unlike that for chemistry journals and physics journals, there is no significant correlation between citing half-life and number of source items and number of citations, respectively. This is unique among the three subjects under study.

Comparison among the significant correlations listed in Table 3 demonstrates the similarity in the existence of significant correlations among number of source items, number of citations, impact factor, and immediacy index and between cited half-life and citing half-life for the three subjects under study except that there is no correlation between number of source items and impact factor and immediacy index, respectively, for the physics subject. The similarity is also demonstrated for the existence of significantly negative correlations between citing half-life and other scientometric indicators, except positive for cited half-life, for the subjects of physics and chemistry, but not for the engineering subject. However, difference rises for the correlation between the cited half-life and other scientometric data among the three subjects. In general, there is no significant correlation between the cited half-life and other scientometric indicators. To substantiate this general observation, the Fisher tests are conducted in the next section.

Table 3. Pearson correlation coefficient ($\alpha = 0.05$) between scientometric data of I: Physics; II: Chemistry; III: Engineering

| | Number of source items | | Number of citations | | Impact factor | | Immediacy index | | Cited half-life | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of citations | I | (0.84[a], 0.00[b]), 233[c] | | | | | | | | |
| | II | (0.88, 0.00), 93 | | | | | | | | |
| | III | (0.87, 0.00), 94 | | | | | | | | |
| Impact factor | I | (0.09, 0.18), 233 | I | (0.24, 0.00), 236 | | | | | | |
| | II | (0.32, 0.00), 92 | II | (0.41, 0.00), 94 | | | | | | |
| | III | (0.26, 0.01), 94 | III | (0.44, 0.00), 94 | | | | | | |
| Immediacy index | I | (0.12, 0.08), 230 | I | (0.27, 0.00), 230 | I | (0.90, 0.00), 230 | | | | |
| | II | (0.53, 0.00), 90 | II | (0.65, 0.00), 90 | II | (0.84, 0.00), 90 | | | | |
| | III | (0.27, 0.01), 94 | III | (0.42, 0.00), 94 | III | (0.60, 0.00), 94 | | | | |
| Cited half-life | I | (–0.14, 0.04), 232 | I | (0.03, 0.63), 235 | I | (0.13, 0.05), 235 | I | (0.11, 0.11), 229 | | |
| | II | (–0.17, 0.10), 92 | II | (–0.03, 0.77), 94 | II | (–0.16, 0.12), 93 | II | (–0.21, 0.04), 89 | | |
| | III | (0.02, 0.85), 88 | III | (0.23, 0.03), 88 | III | (–0.05, 0.67), 88 | III | (0.153, 0.16), 88 | | |
| Citing half-life | I | (–0.30, 0.00), 232 | I | (–0.22, 0.00), 233 | I | (–0.14, 0.03), 233 | I | (–0.13, 0.05), 230 | I | (0.46, 0.00), 232 |
| | II | (–0.29, 0.01), 88 | II | (–0.31, 0.00), 89 | II | (–0.55, 0.00), 89 | II | (–0.59, 0.00), 88 | II | (0.33, 0.00), 88 |
| | III | (0.02, 0.84), 90 | III | (0.05, 0.62), 90 | III | (–0.23, 0.03), 90 | III | (0.04, 0.74), 90 | III | (0.34, 0.00), 86 |

[a]: Pearson correlation coefficient (r); [b]: p-value; [c]: number of journals for this subject pair

*Fisher tests*

Table 3 indicates that the strength for significant correlation coefficients varies remarkably from pair to pair. For examples, for the three subjects of this study, the correlation coefficients between number of citations and number of source items are all higher than 0.8. This strength of correlation is significant even from practical point of view. This suggests that the number of citations and number of source items are strongly and positively correlated for the three subjects. On the other hand, the correlation coefficients between number of citations and impact factor are from 0.2 to 0.5, suggesting correlation between number of citations and impact factor is with medium strength for the three subjects of the present study. Interestingly, there is negative correlation of medium strength between number of source items and citing half-life for the both subjects of physics and chemistry. It should be noted that correlation with medium or low strength may not be significant in reality.

To further clarify the strength of the significant correlation between each pair for journals in these three subject fields, Fisher tests are conducted. Let

$$Z = 0.5\log[(1+\rho)/(1-\rho)] \tag{1}$$

be the Fisher's Z-transformation of the sample correlation coefficients ρ. Suppose there is a sample of size n1 from one population and a sample of size n2 from a second population. Under the null hypothesis H: ρ1 = ρ2, Z1–Z2 has normal distribution with mean 0 and variance an asymptotic 1/(n1–3)+1/(n2–3). A critical region of size 5% is therefore [ANDERSON, 1984, P. 122]:

$$|Z1-Z2|/[1/(n1-3)+1/(n2-3)]0.5 >1.96 \ (\alpha = 0.05\ ) \tag{2}$$

Table 4 illustrates the pair-wise difference between correlation for scientometric data with significant correlation for the three samples under study, i.e., physics, chemistry and engineering journals. The table clearly indicates that there is no significant difference for the three subjects in the correlation for majority of pairs under study, i.e., 14 out of 22 pairs. In particular, for the three pairs among the three subjects of the present study there is no significant difference in correlation strength between number of source items and number of citations, between number of citations and impact factor, and between cited half-life and citing half-life. This suggests that the three subjects present the same strength of the correlation between number of source items and number of citations, between number of citations and impact factor, and between cited half-life and citing half-life. For the correlation between number of source items and impact factor, there is no significant difference between essential journals of chemistry and engineering. For the correlations between number of citations and immediacy index and between impact factor and citing half-life, no significant difference is observed between essential journals of physics and engineering. For the correlations between citing half-life and number of source items and number of citations, respectively, there is no significant difference between physics and chemistry journals.

On the contrary, significant difference exists for the three pairs among the three subjects between impact factor and immediacy index. The significant difference in the correlation also exists between essential chemistry and engineering journals for the pairs of immediacy index and number of source items and number of citations, respectively. There is also significant difference between physics and chemistry for the correlation between immediacy index and number of citations. For the correlation between citing half-life and impact factor, significant difference is observed between essential journals of physics and chemistry and between chemistry and engineering.

Table 4. Pair-wise difference between correlation for scientometric data
I: Physics; II: Chemistry; III: Engineering

| | Number of source items | Number of citations | Impact factor | Immediacy index | Cited half-life |
|---|---|---|---|---|---|
| Number of citations | 1.5(I&II)<br>0.32(II&III)<br>1.1(I&III) | | | | |
| Impact factor | NA(I&II)<br>0.40(II&III)<br>NA(I&III) | 1.6(I&II)<br>0.26(II&III)<br>1.9(I&III) | | | |
| Immediacy index | NA(I&II)<br>2.1*(II&III)<br>NA(I&III) | 3.9*(I&II)<br>2.2*(II&III)<br>1.3(I&III) | 2.0*(I&II)<br>3.5*(II&III)<br>6.2*(I&III) | | |
| Cited half-life | NA(I&II)<br>NA(II&III)<br>NA (I&III) | NA(I&II)<br>NA(II&III)<br>NA (I&III) | NA(I&II)<br>NA(II&III)<br>NA (I&III) | NA(I&II)<br>NA(II&III)<br>NA (I&III) | |
| Citing half-life | 0.07(I&II)<br>NA(II&III)<br>NA(I&III) | 0.76(I&II)<br>NA(II&III)<br>NA(I&III) | 3.7*(I&II)<br>2.5*(II&III)<br>0.70(I&III) | NA(I&II)<br>NA(II&III)<br>NA (I&III) | 1.3(I&II)<br>0.07(II&III)<br>1.2(I&III) |

NA: Not applicable;
*$\alpha = 0.05$, pair-wise difference between correlation>1.96, the null hypothesis is rejected.

## Summary and conclusions

The present study examines the relationship and difference between the scientometric data for essential journals of physics, chemistry, and engineering. The following conclusions may be drawn for the results of the present study.

1. For all the scientometric indicators of this study except the cited half-life, there is no significant difference between the essential journals of physics and chemistry indicating similar citation behavior among the scientists.

2. There is no significant mean difference in the citing half-life among physics, chemistry and engineering.

3. Significant mean difference is generally observed for most of the scientometric indicators between engineering and physics or between engineering and chemistry demonstrating the difference in citation behavior among engineering researchers and scientists in physics or chemistry.

4. Comparison among the significant correlations from the Pearson tests demonstrates the similarity in the existence of significant correlations among number of source items, number of citations, impact factor, and immediacy index and between cited half-life and citing half-life for the essential journals of physics, chemistry and engineering.

5. Difference arises for the correlation between the cited half-life and other scientometric data among the three subjects of physics, chemistry and engineering. In general, there is no significant correlation between the cited half-life and other scientometric indicators.

6. The three subjects of this study present the same strength of the correlation between number of source items and number of citations, between number of citations and impact factor, and between cited half-life and citing half-life. Significant difference in strength exists for the three pairs among the three subjects between impact factor and immediacy index.

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